

# Design of a Medical Injection System for use During Contingency Space Operations

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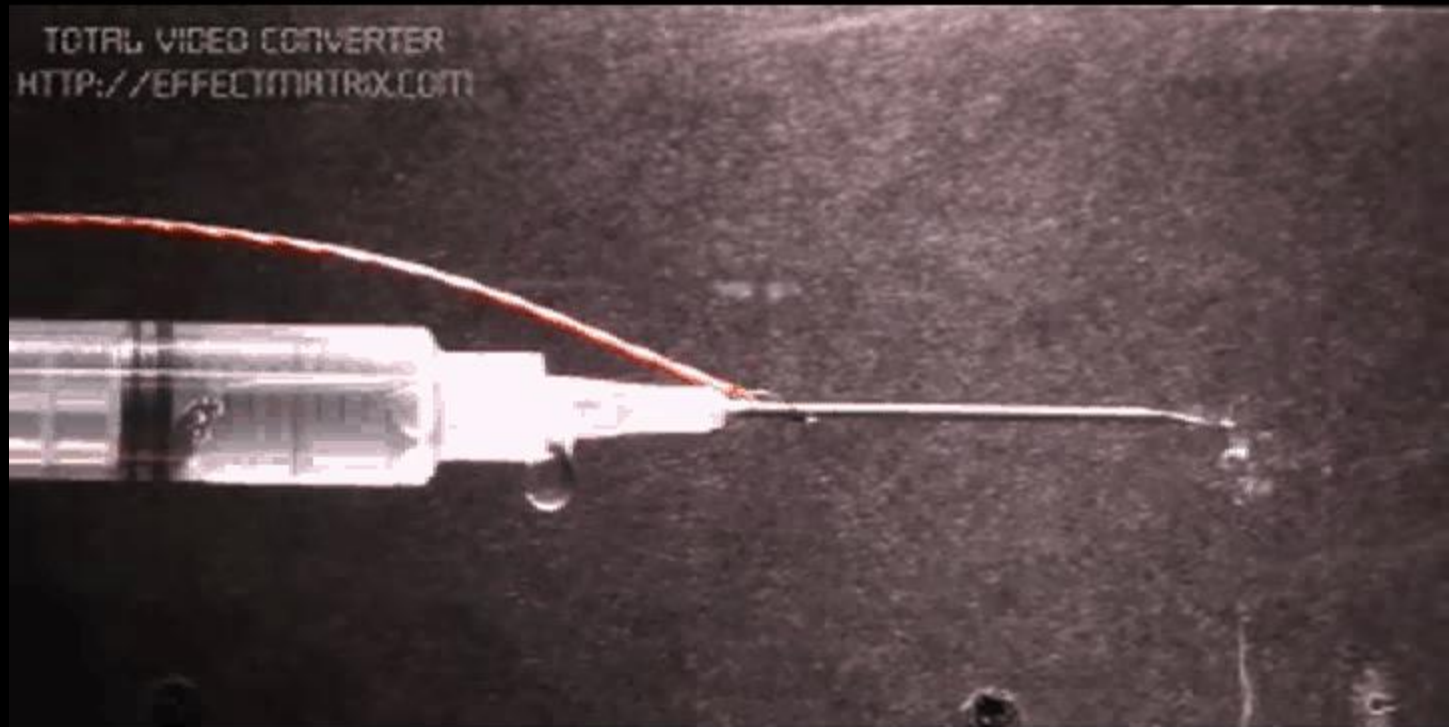
# Project Aim

- “Given the possibility that vehicle failures could result in crew needing to remain in Extra-Vehicular Activity (EVA) suits ..., and given that medical operations may need to provide medications via injection during that time, NASA must develop reliable methods for delivering such medications through the EVA suit”

# Development Considerations

- Temperature and pressure dependant properties of the medication
- Temperature of the syringe and needle
- Ullage bubble formation in moderate vacuum
- Boiling and outgassing in high vacuum
- Crew members will be gloved
  - Operation of injector
  - Risk of accidental needle stick
- Legacy hardware applicability

# Testing in a Vacuum - Syringe



# Preliminary Testing

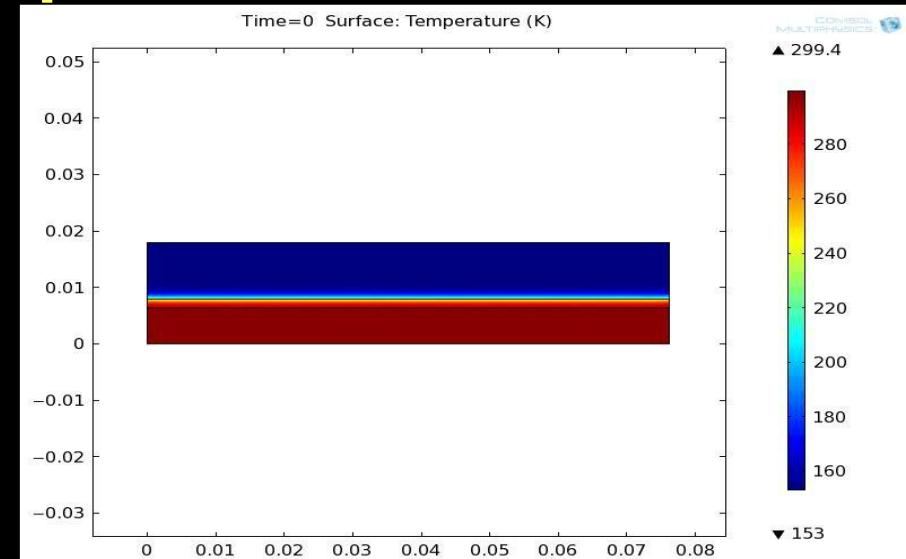
# Dexterity of EVA Gloves

- To determine how the geometry and size of a potential injection device affects a gloved operator's ability to provide an injection, different syringes were manipulated with EVA gloves in a simulated pressure environment.

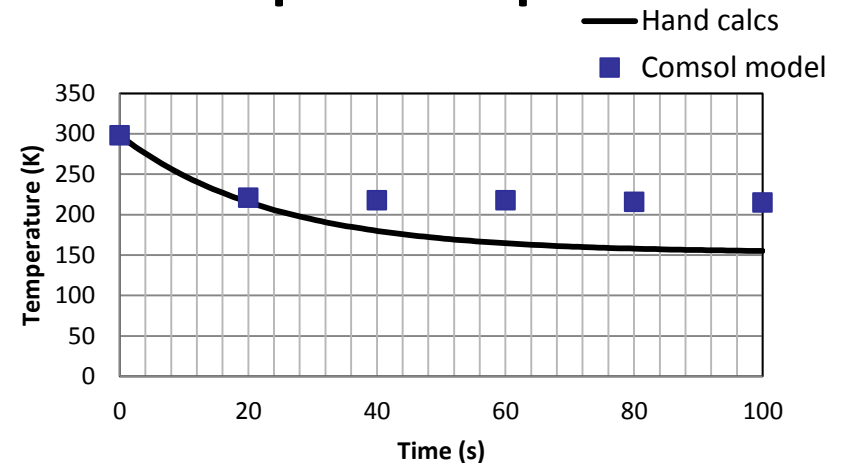


# Energy Transfer Modeling for Liquid Temperature

- Unsteady State Energy Transfer
  - <25s to reach “viability limit” of medication for both high and low temp extremes
- Steady State Energy Transfer
  - Ave 7 - 7.5hr to reach 99% steady state without thermal conditioning or insulation



## Temperature profile





# Apollo Injection Capabilities

Biomedical injection  
patch with red stitching

Photos courtesy Bill Ayrey, ILC Dover





# Silicone Injection Disk

Clear side (facing  
body):  
97.1% Si  
1.6% Cl



White side (facing  
out):  
97.9% Si  
1.5% Ti

0.1 in thick

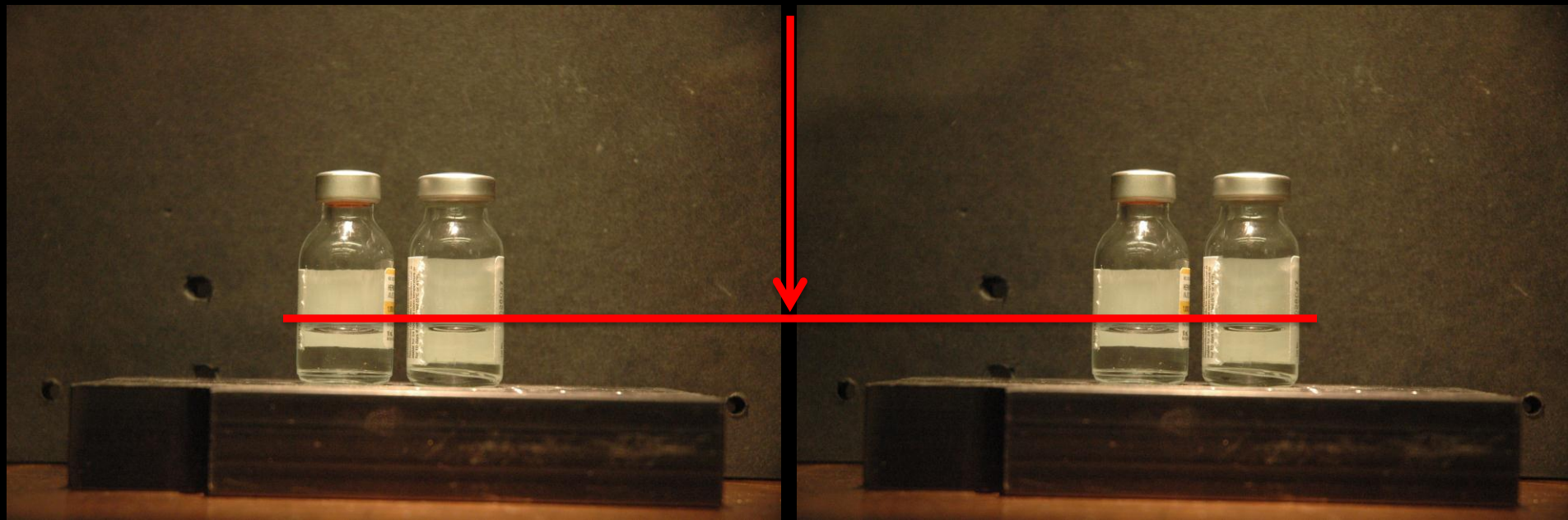


# Testing Vials in a Vacuum

Vials at 755 torr

Vials at 0.22 torr

Fluid Level



At low pressure, no fluid was lost to the atmosphere through the punctured septa

# Testing Rubber Septa for Suit Interface

- Testing was conducted on 20 varieties of septa
  - Standard environmental, thermal, or vacuum
  - Puncture force and seal examined
- 0.125" thick silicone septa coated with either FEP or ETFE is recommended



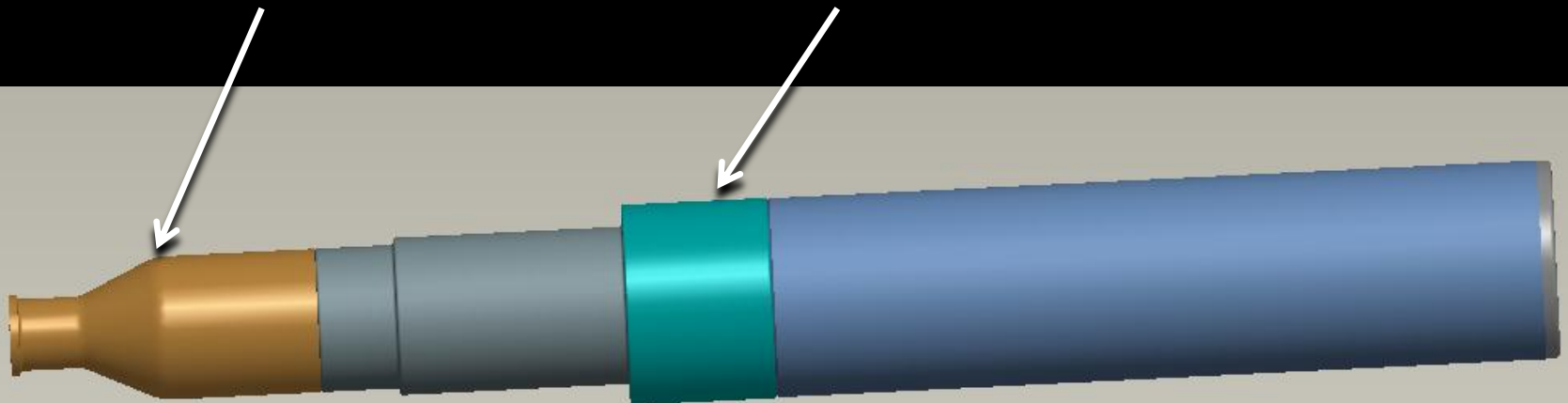
# Prototype Design



# Current Design: Whole Injector

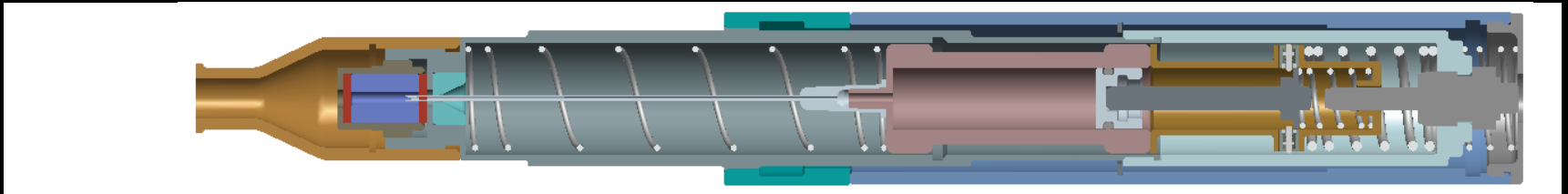
Adapter for shirt  
sleeve environment

Lock ring prevents  
inadvertent  
deployment

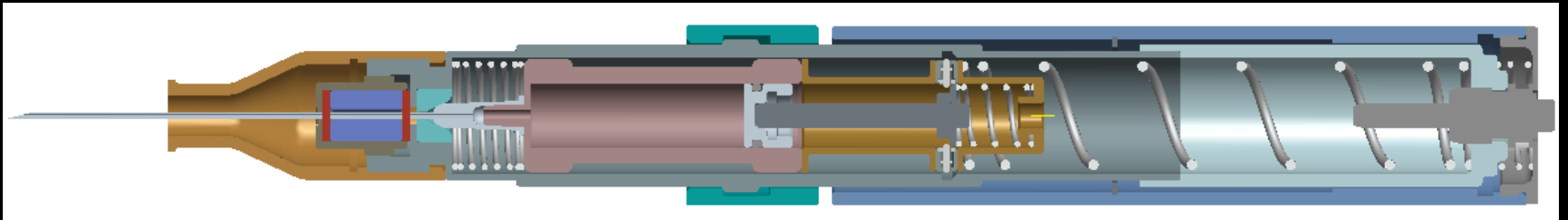


# Current Design: 3 States

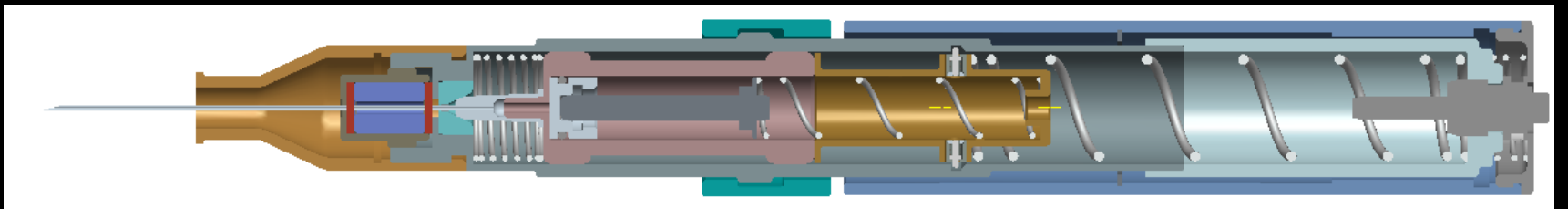
Ready:



Injected:

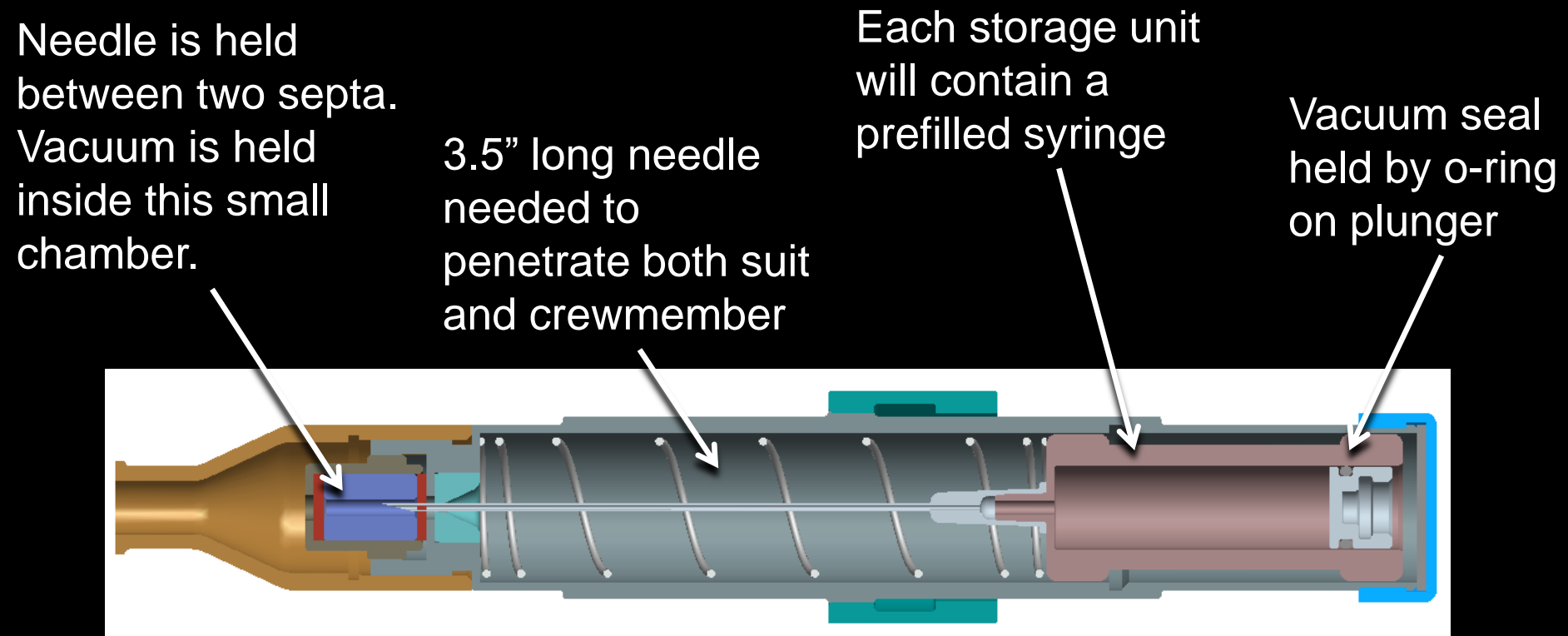


Delivered:



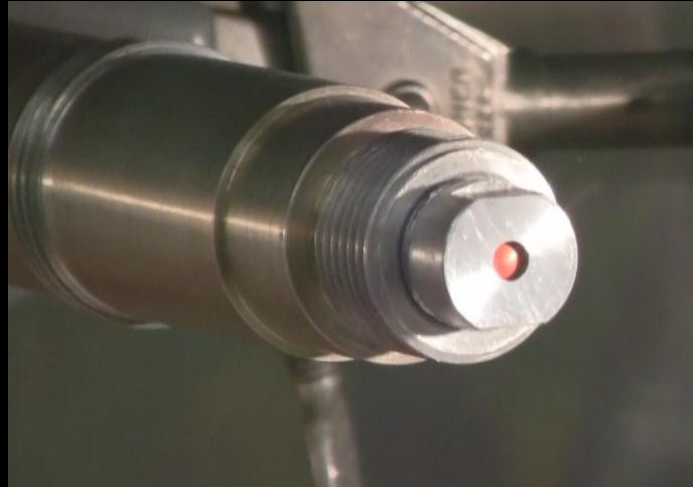


# Current Design: Med Storage



- Vacuum seal is held between tip of needle and syringe plunger. The rest of the injector is exposed to the ambient environment.

# Prototype Testing



- Vacuum testing
  - 16 hrs at 2.5 psia
  - 1 hr at 0.04 psia
- Pressure box testing
  - 19 psia
    - Represents pressurized septum
  - 4.3 psia
    - No liquid leaks between the suit and the leg.



# Usability Testing

- Diameter of the device is constrained by two drivers
  - EVA glove testing
  - Diameter of the syringe



# Conclusion

# Project Archive

- Project has completed reviews by:
  - Medical Operations Board (MOB)
  - Space Medicine Configuration Control Board (SMCCB)
  - System Requirements Review (SRR)/System Definition Review (SDR)
  - Preliminary Design Review (PDR)
- Project has been archived as of 12/31/11

# ISIS Project Team

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